# Report for 2005VI50B: Water Usage for Papaya Production During Drought in the U.S. Virgin Islands

Publications

- There are no reported publications resulting from this project.

Report Follows

**Problem and Research Objectives**

Drip irrigation technology permits the efficient use of water and can help maximize the use of semiarid lands for agricultural use. This technology is particularly suited to widely spaced crops as papaya. Though multiple field trials have shown the economic beneficial use of drip irrigation on vegetable and herb production in the Virgin Islands (Palada et al, 1995; Crossman et al, 1997; Palada and O'Keefe, 2001) minimal information is available on the use of drip irrigation for papaya production (Kowalski and Zimmerman, 2001). It has been suggested that the water needs for papaya in Hawaii are ideally supplied with 100 mm of rainfall each month (Nakasone and Paull, 1998). This amount is seldom encountered in the semiarid climate of the Virgin Islands where erratic rainfall patterns and extended dry periods are the norm. Also, the local preference is for large, greater than two pounds, red papayas while most papaya research from Hawaii has focused on small, yellow one-pound fruit. Not only are the varieties different between the Virgin Islands and Hawaii but also the soil. The soils of the Virgin Islands are calcareous, having a high pH around 8 versus volcanic base in Hawaii. Breeding and selection of papayas at the University of the Virgin Islands has resulted in early bearing varieties that meet the fruit preferences of the Virgin Islanders (Zimmerman and Kowalski, 2004).

The objectives of this research were to develop a commercial papaya producing field plot that incorporates drip irrigation and mulch for growing selected papaya varieties at multiple spacing regimes and measures water usage during the dry season in the U. S. Virgin Islands. Specifically to:

1) To integrate water conservation through drip irrigation and mulching into papaya production
2) To determine water requirements of papaya grown under multiple plant spacing regimes
3) To determine the production of papaya as influenced by spacing under drip irrigation and biodegradable mulch

The crop farms in the U.S. Virgin Islands are mainly comprised of small farmers. The average amount of land for a crop farmer is 4.7 acres (National Agricultural Statistics, 2000). The small size limits the investment the farmer can make to produce a crop. They have to see a strong benefit to a technology before they invest in it and adapt it to their farming practices. Papaya requires nine months from seed, in the early varieties, to have a marketable crop. To have fruits available during the holiday season and peak tourist season, papayas need to be planted in late February or March. However, February through August are normally the driest months of the year.

The development of a half acre papaya plot with drip irrigation, mulch and multiple papaya plant spacing regimes was established to evaluate the amount of water needed to grow papaya during the normal dry season. Water is most often the limiting factor to crop production in the U.S. Virgin Islands. The most efficient use of water can result in economical gains for the local farmers. By establishing the beneficial influence drip irrigation and mulch has on papaya production, the small scale farmers will be encouraged to grow papayas and apply the irrigation technology to situation and incorporate sustainable production practices, water conservation and improve soil stewardship.

**Methodology**

Papayas were initiated from seed under greenhouse conditions during March. Four papaya varieties were selected for the replicated water usage and spacing study. The varieties were: 'Maradol', 'Tainung 5', 'Trini x Washington 5' and 'Yuen Nong 1'. When the seedlings were 10-15cm in May, they were transplanted to the field in three spacing arrangements. The spacing was 3 m x 3 m, 3 m x 2 m and a staggered double row 3 m x 1 m with 2.5 m between each set of double rows. There were eight rows per spacing regime that were divided into two row blocks. Each row had two plants of each variety. Guard rows of other papaya varieties were planted around the plot to negate border effects.

The plants were hand watered at the time of planting with a fertilizer and fungicide solution. Drip irrigation lines, with 1 m spaced emitters, were installed at the time of planting. The irrigation system was set up with a Dosmatic injector and each spacing block had its own water meter. Two sets of soil moisture tensiometers were installed within rows of each papaya block. Each set of tensiometers consisted of two meters to record soil moisture at 15 cm and 30 cm depth. The tensiometer readings were recorded twice a week by a student assistant. The plots were mulched with grass hay mulch when plants were 0.8-1 m tall.

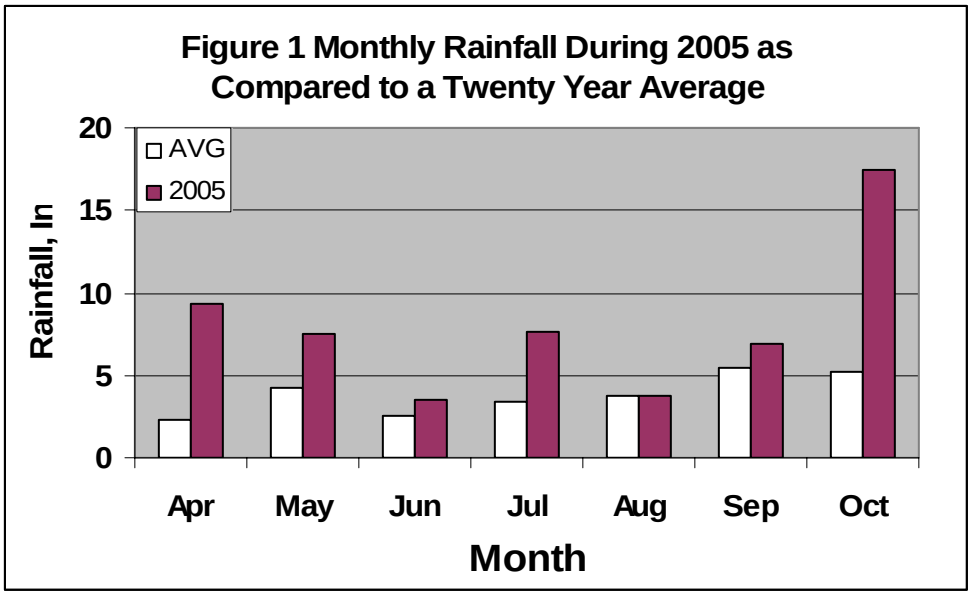
After one month of field establishment, floral buds had formed, allowing for the papaya plants to be sexed and thinned to one plant per hill. None bearing male plants were removed and one, preferably hermaphrodite, papaya was left to grow. A month after anthesis, the height to the first set fruit was recorded. At the time of fruit harvest, the stem diameter was recorded at 0.5 m and 1.0 m. Production data was collected as the fruits ripened.

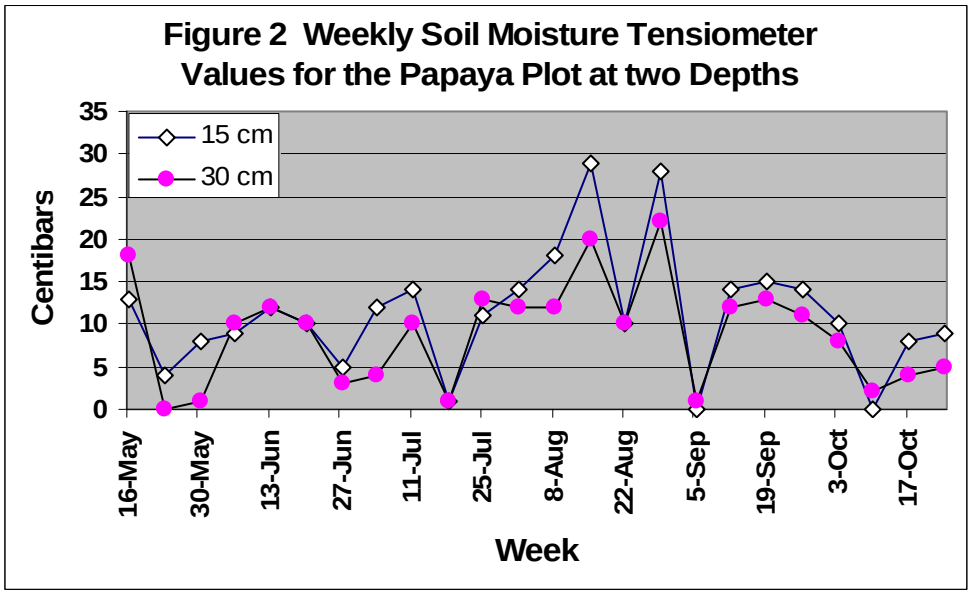
A prebachelorate college student was funded through this grant. The student was actively involved in all aspects of this papaya study. His time has been spent on the following activities:
1. Papaya seed planting and recording of seedling emergence;
2. Transplanting of the papaya plants to the field and installation of the drip irrigation lines;
3. Assembling the tensiometers and calibrated them;
4. Installing the tensiometers in the field and regularly recorded soil moisture readings;
5. Assist with the sex determination and thinning of trees;
6. Recorded height to first flower, height to first fruit, stem diameter and fruit characteristics;
7. Developed spreadsheets for data parameters and entered the data in the computer.

**Principal Findings and Significance**

This study was to investigate the amount of water usage during the first six months of establishment at varying papaya spacing intervals during the dry season. Due to the unseasonable abundant amount of rainfall during the normal dry season and course of this research (Figure 1), supplemental irrigation water was only applied once. The heavy rainfalls resulted in even water distribution throughout the test plot. The papaya growing plot was at or near field capacity during most of the first six-month trial (Figure 2). This ideal environment caused the papaya plants to grow well and be productive. The mulch was a benefit during the heavy rains by preventing erosion to the soil. The mulch also suppressed weed growth and

reduced soil evaporation. The mulch kept the soil cool and moist. Papaya roots were present at the interface between the soil and the mulch indicating an ideal environment for growth and water absorption. Also, as the straw mulch decomposes nutrients are being released that are available to the plants.




Data was collected on height to first flower. The data was collected when the plants were 1 to 1.5 m tall. The height to the first initiated flower was within 1 m of the soil surface for all papaya varieties (Table 1). Though there were differences between papaya varieties, two distinct groups are evident. Papaya varieties 'Maradol' and 'Trini x Wshington 5' have a more compact form and initiate flowers lower than either 'Tainung 5' or 'Yuen Nong 1'. However, there was no significant difference within a papaya variety for the height at which the first flower formed among the tree spacing intervals.

The height to the first fruit indicates where the fruit column fruit begins. This is indicated by the distance from the soil surface to the first set fruit results are higher than for the first flower (Table 2). Most often the first flowers initiated are sterile and do not set fruit. This is due to the physiological change of the plant from juvenility to maturity. The differences among the heights at which the first fruit were set were not significantly influenced by the plant spacing.

Fruit size is controlled by the genetics of a plant and its environment. Plant spacing had a significant effect on the two papaya varieties that have larger fruit (Table 3). While the 9 x 3 double row spacing yielded significantly larger fruit for 'Maradol', the 9 x 9 m plant spacing had the largest spacing for 'Yuen Nong 1'. This difference can be explained by the fact that 'Maradol' is a short compact tree while 'Yuen Nong 1' is a standard sized papaya tree. The greater area the 'Yuen Nong 1' had to expand its leaves between plants could have benefited the fruit size.

Stem diameter provides an indication of the stem strength to support a full column of fruit. The stem diameter was recorded at both 0.5 m and 1 m above the soil surface. The 0.5 m height is where the compact papaya varieties normally set fruit, while the standard sized trees set fruit closer to 1.0 m. Statistical analysis did not indicate differences between spacing within a height level. However, the thickness of the stem at 0.5 m was significantly thicker then at the 1.0 m level (Table 4). The standard height varieties 'Tainung 5' and 'Yuen Nong 1' had thicker stems at both height measurements then the compact varieties 'Maradol' and 'Trini x Washington 5'.

A papaya workshop, in collaboration with the UVI Cooperative Extension Service, was conducted for farmers and the general public in the St. Thomas and St. John district on September 8$^{th}$, 2005. St. Croix had a similar workshop and field tour for farmers and backyard growers on September 25$^{th}$, 2005. Papaya enthusiasts attended these workshops in their district. Water conservation and the use of both straw mulch and drip irrigation in papaya production were the theme of the workshops. The field demonstration allowed the farmers on St. Croix to walk through the plot, see the plants growing and answer questions arising from what they saw.

**Conclusions and Recommendations**

Though the water requirements for papaya during plant establishment could not be determined due to the excessive rainfall during what is normally the dry season, this study provided baseline data under ideal conditions. Plant spacing did not influence height to first initiated flower, height to first set fruit or stem diameter. However, plant spacing did influence fruit size in two papaya varieties. Tensiometer probes at 30 cm and 60 cm soil depth provide a good indication of soil moisture throughout the growing season and indicated that the top of the soil profile dries before deeper depths even under straw mulch. The mulch was beneficial in controlling weeds, preventing erosion and conserving the moisture in the soil profile. Further research is needed to determine papaya water requirements during field establishment, floral initiation and fruit development under multiple plant spacing regimes

**References**

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*Table 1. Average height to the first flower of four papaya varieties planted in three spacing intervals.*

| Papaya Variety | 9 x 3 (cm) | 9 x 6 (cm) | 9 x 9 (cm) |
|---|---|---|---|
| Maradol | 43.0 | 38.8 | 45.0 |
| Tainung 5 | 63.8 | 61.6 | 61.4 |
| Trini x Washington 5 | 41.5 | 43.2 | 36.6 |
| Yuen Nong 1 | 65.7 | 78.2 | 87.3 |

*Table 2. Average height to the first fruit of four papaya varieties planted in three spacing intervals.*

| Papaya Variety | 9 x 3 (cm) | 9 x 6 (cm) | 9 x 9 (cm) |
|---|---|---|---|
| Maradol | 52.3 | 47.7 | 48.0 |
| Tainung 5 | 82.7 | 71.0 | 74.4 |
| Trini x Washington 5 | 53.8 | 54.9 | 58.8 |
| Yuen Nong 1 | 86.8 | 82.4 | 94.6 |

*Table 3. Average fruit size of four papaya varieties planted in three spacing intervals.*

| Papaya Variety | 9 x 3 (Kg) | 9 x 6 (Kg) | 9 x 9 (Kg) |
|---|---|---|---|
| Maradol | 2.26 a* | 1.89 b | 2.11 ab |
| Tainung 5 | 1.20 | 0.95 | 1.07 |
| Trini x Washington 5 | 0.87 | 0.76 | 0.80 |
| Yuen Nong 1 | 2.86 b | 2.16 b | 4.35 a |

* Differences among spacing intervals within variety followed by a different letter are significant at 0.05 level (LSD).

Table 4. Stem diameter at 0.5 m and 1.0 m after six month of growth in the field.

| | Height at 0.5 m | | | Height at 1.0 m | | |
|---|---|---|---|---|---|---|
| Papaya Variety | 9 x 3 (cm) | 9 x 6 (cm) | 9 x 9 (cm) | 9 x 3 (cm) | 9 x 6 (cm) | 9 x 9 (cm) |
| Maradol | 10.5 | 10.0 | 9.3 | 8.1 | 8.3 | 7.8 |
| Tainung 5 | 12.4 | 12.5 | 12.3 | 11.1 | 10.8 | 10.5 |
| Trini x Washington 5 | 10.5 | 9.9 | 10.8 | 8.3 | 8.1 | 8.7 |
| Yuen Nong 1 | 12.1 | 12.1 | 12.6 | 9.7 | 10.0 | 10.9 |